DOCUMENT RESUME

ED 025 833 EA 001 865

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A Feasibility Study of Providing Regional Data Processing Services.
Wabash Valley Education Center, Lafayette, Ind.
Spons Agency-Office of Education (DHEW), Washington, D.C. Bureau of Elementary and Secondary Education.
Report No-ESEA-Title-3
Pub Date Jun 68
Note-51p.
EDRS Price MF-$0.25 HC-$2.70
Descriptors-Computer Oriented Programs, *Data Processing, *Estimated Costs, *Facility Requirements, *Information Centers, *Personnel Needs

A Title III ESEA study sought to determine the feasibility of establishing a central data processing service by the Wabash Valley Education Center for its member schools. First, current applications of data processing in education were reviewed to acquire detailed specifications for an educational data processing center's hardware, software, and liveware or personnel. Then, surveys, interviews, and other means were used to determine what the Center should do to establish such a facility. This part of the study had six dimensions: Assessment of need and identification of services, operational considerations, resource requirements, fiscal considerations, time considerations, and a pilot study of a computerized payroll problem. It was concluded that although sizable capital outlays would be required to establish a data processing center, manual data processing activities carried out by local schools could be eliminated and more services could be provided. The following recommendations were made: (1) A highly competent and capable staff for the data processing division should be developed; (2) a hardware configuration should be based upon the types of services to be provided; (3) operations should be planned on a priority basis, with highest priority going to the least complex services; and (4) primary attention must be focused on completeness and accuracy of output before it is disseminated. (SS)

ED 025833

A FEASIBILITY STUDY OF PROVIDING REGIONAL DATA PROCESSING SERVICES

Completed For The

Wabash Valley Education Center

Lafayette, Indiana

By

Norbert J. Nelson

Don C. Patton

Lloyd E. Frohreich

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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The work presented or reported herein was performed pursuant to a Grant from the U. S. Office of Education, Department of Health, Education, and Welfare. However, the opinions expressed herein do not necessarily reflect the position or policy of the U. S. Office of Education, and no official endorsement by the U. S. Office of Education should be inferred.

FOREWORD

It is widely held that comprehensive information systems are essential to the effective and efficient operation of educational, industrial, and governmental organizations. Thus, growing attention is given to the problem of integrating man's talents with machine capabilities to achieve results not otherwise easily attainable. Major advances have been made in many industrial and governmental agencies to produce integrated information systems which effectively and efficiently accept, manipulate, and produce computed data. Educational agencies, local school systems in particular, have not made similar advances. This is so for a variety of reasons including problems of economics, inadequate size of individual school units, and satisfaction with traditional opponents. It should be noted that a number of school corporations in Indiana have developed rather sophisticated information systems and great interest has been evident among school officials and staff in many other school systems. It was a result of much interest by member schools of the Wabash Valley Education Center that culminated in Mr. William Floyd, Director of the Center, contacting Norbert J. Nelson, Purdue Unisity, and two of his colleagues, Don C. Patton, and Lloyd E. Frohreich, requesting them to undertake a feasibility study for establishing a data processing center to serve the heads of member school systems. This report is a product of their efforts.

The feasibility study had six dimensions as follows: (1) assessment of need and identification of services, (2) operational considerations, (3) resource requirements, (4) fiscal considerations, (5) time considerations, and (6) a payroll pilot study.

Appreciation of the study team is extended to Mr. William Floyd, Director of Wabash Valley Education Center, and his staff, for the gracious help extended us. The Board of Directors and other personnel of member schools also were most courteous and helpful. Special thanks is extended to the administrative staff of the Fort Wayne and South Bend schools, the Indiana Department of Public Instruction, the Oakland County, Michigan, intermediate unit, and personnel from the Purdue University computer center for their helpful assistance.

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CHAPTER I

INTRODUCTION

Educational data processing, per se, is not a new idea in the field of education. For many years school administrators, teachers and other educational personnel have concerned themselves with collecting data and processing these data into meaningful translations for assistance in directing the educational process.

In recent years, however, educational data processing has taken on new dimensions involving many different kinds of operations using complex electronic equipment and many different kinds of personnel including highly skilled and specialized technicians who work with this equipment in carrying out complex processes. This expansion in processing data is not unique to education but has become a necessity for American industrial and other business operations in adapting to and keeping abreast of a rapidly changing and highly sophisticated society. Rapid improvements in American technology paved the way for the development of sophisticated technical devices for collecting, classifying, storing, analyzing and disseminating the many kinds of data required in contemporary society.

The following sections of the report give an introductory overview of current applications of data in processing in education.

Data Processing, Computers and Education

The application of computers in education, by definition in this report, implies the use of computer equipment in any educational institution, whether elementary and secondary or higher education and whether public or private. The immediate objective of data processing is the processing of information to assist those who need these data to help them arrive at some decision or action to be taken. Data processing does not necessarily require the use of computers or other mechanical devices. But the term in recent years has become strongly associated with computer processing. Data

processing in the context of this text will enfold electronics computing equipment as the primary manipulator of input data.

There are data available in all educational systems which need to be analyzed and sorted to be used as a bases for making decisions. Major problems associated with data processing are (1) the objectives or goals the system will attempt to attain, (2) the kind of data that are to be collected, (3) the equipment and procedures needed for manipulating data, and (4) the nature of analysis and use of processed data.

The goals of a data processing system are what the system wishes to accomplish. Desirable goals may include an automated payroll system, a grade reporting system, a pupil accounting system or a critical path analysis revealing step by step procedures for building a new high school. The entire system is a composite of goals and sub-goals that are entertained in the ultimate goal of efficiently and effectively producing educated boys and girls.

An educational system is increasingly faced with growing numbers of children, teachers and a vast amount of data from all sources. Simple hand calculation and tabulation of data is one method of treating and storing information. But with the mass of information needed for reports, records, and analyses this is becoming an ineffective and very inefficient method of handling data. Years have passed since industrial and business concerns recognized this glaring misallocation of time and resources. Educational institutions are slowly arriving at the realization that there are better methods available for doing some tasks that were formerly consuming too much time of administrators, teachers and other personnel. Wholesale shifting of monetary resources to computer equipment that will help management make reliable decisions has long since lost the stigma of being uneconomical and impractical. But to the contrary use of electronic equipment is thought of as contributing to more efficient use of available resources.

Input of Data

Data which are to be processed are identified as inputs. Data processing techniques for recording and manipulating data commonly use the punched card for input of data into

equipment for processing. The punched card has inherent advantages for storing and manipulating data. These include:

1. The speed of processing varying from fifty to 600 cards a minute.
2. The accuracy of data since it is permanently and indelebly punched in the cards as holes.
3. The flexibility of the data since it can be used repeatedly and in various ways.

The keypunch is the machine used to punch data into cards. An operator punches holes into cards in much the same fashion as a typist uses a typewriter. The keyboards of typewriters and keypunches have many similarities. Often the data is sent through two keypunch operators to insure the accuracy of data being translated from sources documents to punched cards. The second operation is commonly called verification and is done on a verifier which is very similiar in appearance to a keypunch.

The machines used to read cards are described as card readers. A card reader off-line (not connected to a computer), may be used to simply transcribe data from cards to a printed page. The electronic computer has a built-in card reader which translates data either to the memory cells of a computer, to a punched tape, to a magnetic tape, or to a magnetic disk or drum.

It should be noted that a punched card is not the only form in which data can be stored or manipulated. Cards are often too large and cumbersome for systems with extensive data storage requirements. Cards are also a slow method of manipulating large quantities of data. With large and fast processors the data input by cards is too slow and consequently the processor is idle much of the time. A large processor is too expensive to leave idle very long so other methods were discovered for storing data in a more compact form and for transferring data at higher speeds. Therefore, an alternative and faster method of input commonly used is the magnetic tape. Equipment is available which will convert data from cards to tape and back to cards or as printed output. The data are stored on specially designed tape in the form of magnetized dots called characters. A normal 2,400 feet real of tape will store information at a density of 200 to

800 characters of data per inch. That is, a total of 5,760,000 to 23,040,000 characters might be stored on one 2400 foot real of tape. In addition to compactness, magnetic tape offers the advantage of higher input speed into a processor than can be obtained with punched cards. Tape drives can transfer data from the tape to the processor at the rate of 60,000 characters per second.

A third method of storing and manipulating data utilizes the magnetic disk. A magnetic disk-pack normally contains 10 disks which in appearance resembles a stack of common musical records each separated by a space of one or two inches. Each surface, except the top and bottom surface of the pack, is used to store information in the form of magnetized spots on tracks. The equipment used to transfer data to and from the disk surface is called a disk drive. The magnetic disk also offers the advantages over punched cards of compact data storage and of high transfer speeds. In contrast, the magnetic tape is less compact and not nearly as fast. The one major advantage of the magnetic disk over magnetic tape is its random access capability. Data on magnetic tape must be stored sequentially, i.e., in some specified order. Therefore it must be read off and on the tape in the same manner. On magnetic disks the storage and retrieval of data is left to the discretion of the person in control of the equipment. Data does not have to be stored on the disk in a certain sequence. Therefore data that are used often may be stored on disks where they can be quickly retrieved. The ability of the processor to place and retrieve data in a non-sequential manner is called "random access" processing and the storage device used is the magnetic disk contained in a disk pack.

The single most important advantage that card input has over both magnetic tapes and disks is its reliability. Some consider that fewer errors are likely to occur in transferring data to and from cards than in transferring data to and from either tapes or disks. Many data processing systems are effectively utilizing both tapes and disks in storing and manipulating data.

Another method of input which is gaining respectability in sophisticated data processing systems is the on-line terminal access method of processing data. Remote or proximate terminals are tied directly to the central processor through common carrier duplex lines such as those used by telephone or telegraph companies. Those terminals in close proximity use some type of conducting wire, particularly those in the same building as the computer. Over longer distances either conducting cables or micro-wave carriers are used to transfer messages from the terminal to the processor and back.

Terminals exist in many forms. One of the simplest is a keyboard terminal which has the appearance of an electric typewriter. The operator types messages into the computer and the computer answers on paper forms contained in the keyboard terminal unit. Terminals also may be off-line. That is, data are transferred to equipment which is not directly connected to the processor. The data are then transmitted to the computer when the computer is ready for processing. Contact with the data processing center is often made with a modern or data set. Data sets are devices similiar to telephones which make initial contact with the computer and are sometimes used to transmit simple information.

More complex terminals include display screens which are in the form of cathode ray tubes and will display anywhere from 240 to 960 characters at one time. Charts, graphs, and printing in any form may be projected visually on the cathode ray screen.

Data may be transferred at speeds from 148 words to 2400 words per minute to and from terminals. With on-line equipment, however, the transmittal speed is usually limited by the typing speed of the operator. Display screens at terminals are being used for some methods of computer assisted instruction. The concept of computer assisted instruction will be discussed later in the report.

Two other methods of input which are worthy of mentioning are the optical character reader and the optical mark reader. Both are used as scoring devices. The latter is

familiar to those who have used mark sense cards. The optical mark reader can detect marks on cards and make appropriate designations of correct responses, incorrect responses, etc., on the card itself. The optical character reader is a device which gained recognition through usage by American banks in reading numbers and letters on checks. The optical character reader is finding usage in education with endeavors to read and record essays, articles, and other printed matter in special character form. Optical readers appear to have the potential to be an invaluable tool in years to come.

There are numerous kinds of applications of the data input concepts discussed in this section. Various vendors of data processing equipment are constantly coming out with new and improved procedures. Only some basic applications are considered in this document.

Output of Data

In the preceding discussion, attention was devoted to describing procedures for getting data into a central processor. Input which has been manipulated into some form that people using it can recognize is known as output. The printed page is the output medium that is most often used to place output in readable form. The device used to produce printed reports or documents is called the printer. Printers are normally on-line devices in various degrees of sophistication which will print at speeds carrying from 200 to 1200 lines per minute. Faster printers are being developed for use in the near future. The printer does not necessarily have to be on-line. The processor (or computer) can transfer its processed data to cards, magnetic tape, or magnetic disks for later transmission to printed form. Often output is left in punched card form.

Processing

The intermediate step between input and output is called processing. A data processing system can manipulate data into almost any form needed by the user. The only

limitations are the size and speed of the computer and the ingenuity of people controlling it. The users of data processing equipment must constantly concern themselves with these two restrictions.

Processing of data is normally done by the computer and may include any or all of the following operations:

1. Sequencing
2. Grouping
3. Selecting
4. Calculating
5. Editing
6. Correlating
7. Summarizing

The first three operations can be classified as sorting operations. Sequencing places data in some prescribed order. Grouping brings similiar kinds of data together. Selecting involves separating data according to some prescribed criteria.

The calculatory operation is what the computer is noted for. Calculating involves arithmetic operations such as adding, subtracting, multiplying and dividing. Many times the calculating operation is done in connection with other operations.

Editing involves making the printed form more readable as well as making sure input data is in the proper form. The correlating capability brings data of two or more groups together and makes comparisons. Summarizing is a process involving the use of other operations listed to reveal an end result or conclusion after the operation has been completed.

Equipment used for processing the data is basically of two types, unit record equipment systems and electronic computer systems. Unit record systems do not make use of electronic computers. Input is normally in the form of a punched card. A unit record system commonly consists of (1) a sorter which performs the sequencing, grouping, and selecting operations; (2) a calculator that performs arithmetic operations; and (3) an accounting machine that performs addition, subtraction, editing, comparing, correlating, and summarizing. Unit record equipment is electromechanical and uses wired control panels which are changed for different jobs. A computer is electronically

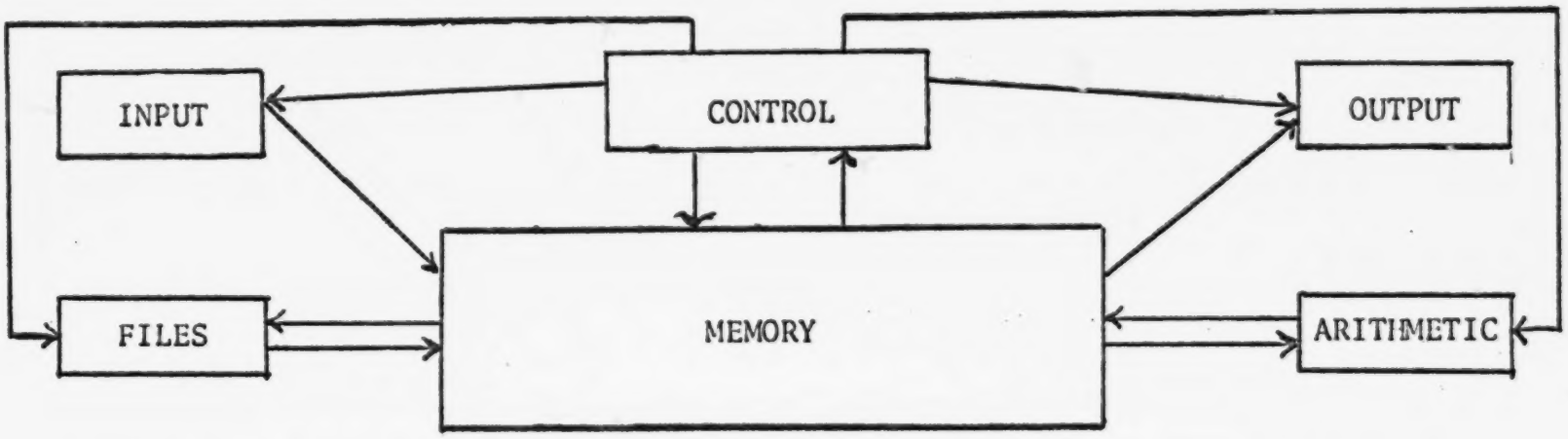
operated and must be programmed with a step by step set of instructions on how to manipulate data.

Considerable debate has occurred in recent years over the role of the computer and the great power that it has. Basically, however, the computer must be told what to do, how to do it, and when to do it. The human mind is still responsible for the function, organization, and operation of the computer. Usually the real advantages of the electronic computer are considered to be its fantastic speed and the capability for storing great quantities of data for multiple-processing functions. Herein lies its ability to perform the multitude of operations that relieve the organization's staff and administrators from time consuming and monotonous tasks. In addition the computer can provide important information for administrative decision making.

The general diagram of a basic computer system will help illustrate how it functions. The following diagram is a graphic display of the computer's most important components.

FIGURE I

DIAGRAM OF A BASIC COMPUTER SYSTEM



The control section tells the input device what information to enter into memory, when to enter it and where to place it. For example, it tells the arithmetic section what operations to perform, where in memory to find the information and where to store the results. It also locates the file information and stores it in memory and finally controls the output devices and determines which information is printed or written.

This is all accomplished by a stored program written by a programmer. To recapitulate, information is read from input devices into memory where it is combined with other data and/or manipulated back and forth between the memory and arithmetic systems to produce desired results. The results are then communicated to users or other machines by output devices.

In summary, modern educational data processing systems, although complex mechanically and electronically, are relatively simple in application for processing educational data. The control is manipulated by a man who communicates with the processor. When the communication is properly completed, data processing capabilities are available which would take up to thousands of man hours to perform manually.

Applications of Data Processing in Education

Consideration must be given for the extent and usage of data processing equipment in today's schools from both a realistic and conceptual framework. The realistic situation trails conceptual considerations by several years. What can be done and what is being done are far removed from each other as we look at on-going projects and applications of computer technology in education. Colleges and universities are doing more and proceeding faster than their counterparts--the public and private elementary and secondary schools. There are reasons for this situation but the answers do not fill the existing gap with any degree of satisfaction. Perhaps the most cogent argument for the apparent slowness of schools to accept computer technology is their lack of understanding or knowledge of what a good data processing system can accomplish. Another reason often espoused is the rigid determination of teachers and administrators to hold on to the existing ways and means of handling data and information. These arguments may have been acceptable years ago, but, with increasing demands made on teachers and administrators for data and reports, such arguments are not valid in our contemporary educational setting.

From a conceptual standpoint, data processing systems can do almost anything that is presently done including those activities which require a statistical or accounting report. In addition, they can do much more. For purposes of this report the magnitude of data processing applications will be revealed by describing areas of application that exist in part in many functioning educational systems.

Budget Accounting includes such services as request and estimate analysis, allocation and expenditure by categories, cost analysis by function, cost analysis by performance, cost analysis by program, projected costs by category, notification of impending deficiencies or surpluses, and reports to local, state, federal and other agencies.

Payroll Accounting includes the preparation of checks for certified and non-certified personnel; maintenance of employee accounts concerning withholding tax, insurance, retirement, Social Security, annuities, etc.; preparation of reports to individuals and other state organizations for taxes, retirement and insurance; salary accounting by various categories, function, or program.

Purchase Accounting is accounting for products and vendor statistical information; analysis of disposition of purchases goods and services; encumbrance and release of funds for purchased goods; follow-up and status of purchase orders; purchasing information by budget category, function or program.

Inventory Accounting is critical for particularly large school systems. Indigenous for this kind of accounting are requisition procedures for stock items; autonatic reordering; counts of materials and equipment in stock or in use; allocation of costs to budget categories, functions or programs.

Buildings and Grounds Accounting including up-to-date information on acquisition, acreage, cost, improvements, and current value of all buildings and real estate; preparation of reports and information for insuring real property; scheduling of preventive maintenance; replacement scheduling; repair scheduling and costing; operation analysis and costing for utilities such as water, electricity, telephones, air conditioning and heat.

Accounts Payable and Receivable involves the creation of bills, crediting and debiting accounts, and follow-up for unpaid bills.

Cafeteria Accounting would be of value for ordering inventory and payment for food and cafeteria equipment and an analysis of food prices and consumption habits of students.

Audio-Visual and Library Accounting for ordering, cataloging and requesting books and audio-visual equipment; analysis of use of equipment and materials by teacher, department, subject or pupil; analysis of maintenance and cost.

Personnel and Hiring Information is of special value in larger systems and could provide an analysis of interview ratings and prospective employee qualifications; data on credit, experience and qualification of current personnel; job evaluation; salary determination and information; illness, leave, and vacation records; analysis of education, certification; institution training, georgaphic origin, and mobility patterns of organizational personnel.

Pupil Personnel Accounting involves the prediction of enrollment by grade, school, or geographic area; attendance records and reports; pupil personnel information such as birth date, address, parents and guardians names and addresses, and pupil immigration and health records; mailing of school communications; maintaining permanent record information.

Registration and Scheduling is an important and time consuming activity for teachers and administrators. These functions involve providing a record of course requests; class lists of students programmed in specific courses; conflict analysis; construction of master schedules; pupil schedules; homeroom lists; room and space utilization analysis; extracurricular lists and studies; locker assignments; summer school registration and scheduling; credit records.

Test and Mark Analysis and/or Reporting are two areas that take teachers; and administrators' time. This function could serve the purposes of printing report cards; assignment of credits and grades; determination of semester and cumulative indexes; preparation

of class standings; mark analysis by teacher, course, and grade level; pupil transcripts; summary lists for teachers, department heads, administrative and counselors; failure and incomplete lists; computation of averages, standard deviations, stanines and percentiles for various achievement and ability tests; underachiever lists and deviations from normal expectations on the basis of test and grade reports.

Research Applications are particularly aided by the use of data processing equipment. These equipment are helpful in statistical analyses of data that otherwise would take hundreds of man hours to compute or that probably couldn't be handled in any other way.

Data Processing Technology can be a useful program application in a school system that wishes to prepare students for employment as technicians in this field. In particular, courses can be organized to orient students to the field of data processing and computer systems; preparation for those who will use the computer as a tool in doing computational work and research; and preparation of students who are interested in becoming programmers, data processing managers, keypunch operators, and system machine operators.

Computer Assisted Instruction is an application of computers that is increasingly becoming more important in the field of education. Programmed learning may be an essential aid to instruction under conditions where large enrollments make traditional methodologies impossible to carry out. The use of a computer will not replace the teacher but will aid the teacher in courses which require drill and repetition for learning a given subject such as mathematics, spelling, sentence construction, parts of speech and some of the sciences. The use of computer assisted instruction technique relieves the teacher of repetitive classroom procedures which require much of the time and energy of the teacher. In turn, the teacher can allocate more time to lesson preparation and individualized instruction.

Auxiliary Services provided by a data processing system are many and varied. Such operations as the following might become a part of the processing system.

1. Bus routing and scheduling by central path analysis lends itself to be programmed on a computer.

2. College admission studies can be utilized to determine which colleges are preferable for students of different abilities and achievement records.

3. Decision making is enhanced by the use of cost analysis of programs and functions for budget preparation. Decision making by administrators is further enhanced by the use of data analysis and information as a by-product of reports and studies of the preceding operations done by the computer.

4. Dropout analysis and predictions can be done with proper programming.

5. Identification of pupils with special needs and handicaps can be made with a functional data processing system.

There presently are many, if not all, of the foregoing operations done by some computer installations in educational institutions. However, it is doubtful that any one installation is performing all of the mentioned operations. Many school systems do not lend themselves well to certain specific operations. Therefore, studies must be made to determine which operations lend themselves to usage in a particular application.

Introducing Computer Systems in an Educational Organization

The introduction of a complex computer system into an educational organization includes problems of comprehension and support of its members as well as problems of design of the technical parts of the system. When the computer system is installed it will effect the behavior of a number of administrators, teachers, and students.

It must be recognized that many people tend to resist change. Before widespread acceptance of the system can be realized, a number of unanticipated consequences, failures, and obstructions may have to be overcome. Often, principals and superimtendents or the managers of organizations can be the most resistant to new ideas and programs. The whole concept of change is involved with the attitudes of organizational members. Much of the literature on attitudes suggests that attitude formation and change do not come in a logical manner or sequence. Attitudes are often more dependent on emotion than on pure logic. That a well conceived plan, logically constituted, will be automatically accepted by anyone who listens is purely unreasonable. To assure a superintendent that a computer system can perform many tasks when a school in another part of the state is getting poor output does not seem to be very reasonable in light of the

superintendent's knowledge of an unworkable system. Simply because a school manager may not be able to understand how a new system will work may be enough to discourage him, especially when he has always been and always will be able to understand the old way of doing something.

Status also has much to do with the acceptance or rejection of change. There is status in the position where a superintendent or principal understands and can explain a system as it exists. Introducing a new system that cannot be explained involves some loss of status.

The person or persons introducing change also must be cognizant of the informal relationships that exist in an organization. Making changes often involves the rearrangement of existing informal relationships. If too many or the wrong kind of informal relationships are tampered with then disharmony and disorganization may result. Often force is applied as a means to bring change into the organization. Sometimes this will work but it will result in increased resistance to any further attempts to introduce change. The wise approach is to consider the effects of changes on individuals and groups within the organization, and then to plan the best method to proceed with the least disruption and to solicit the most support.

Introducing a computer system involves a complete understanding of the forces, motivations, values and attitudes of people within the organization. Often acceptance to change can be accomplished if organizational members are involved in the plans and procedures for introducing a new innovation into the system.

Changes also are easier to handle if the objectives of a new system are understandable and explained in a rational manner. For example, if a new system will be more efficient and time-saving this point should be emphasized repeatedly. Communication is important where attempts are to be made to initiate new ideas and plans. If communication barriers exist within an organization it is difficult to introduce change. Trying to understand the resistance to change means trying to comprehend the real causes behind

resistance. If one understands the causes for resistance, the real problems can be tackled and dealt with realistically.

Studies should be made involving the human side of change as well as the technical side. Before introducing a computer system into an organization, the personnel directly and indirectly affected by its operation should be made fully aware of what the new system will do, can do, and what effect it will have on each school and individual within that school. Therefore, a workable system of communicating with the personnel involved and an effective in-service training program should be established.

Selection of Operating Personnel

The number of people needed to operate a data processing system varies from system to system and is dependent on several factors such as the size of the system, sophistication of the equipment and the needs of the users of output. Regardless, emphasis must be placed on selecting the highest quality personnel available to operate a data processing center. It matters little that a system has the latest and most sophisticated equipment on the market if the personnel are not trained and skilled concerning the center's operation. Probably more data processing systems have failed to operate or function at efficient levels due to inadequate personnel than for lack of funds or satisfactory equipment. The products and input of the system is mostly dependent upon its personnel. There can be no changing of users' attitudes toward a system once the user has received faulty or incomplete information as the result of errors made by operators in the data processing system.

Therefore, it was considered important to discuss in some detail the qualifications and job descriptions of personnel commonly employed in an educational data processing center.

Director of Information Systems

The director of information systems reports directly to the chief administrator of the educational agency. He has the overall responsibility for seeing that accurate

information of the type required is where it should be on time. This is top level involvement and is necessary for an efficient operation. The person must possess great skill and ability plus the authority to make crucial decisions and give coherent answers when needed. The director will be involved with organizing, preparing, and giving meaningful presentation to administrators and school boards. He must command their respect.

The director should be an educational leader and not necessarily a technician. He must be one who has had considerable experience in the field of education and the ability to communicate and establish rapport with educators. Directors with extensive technical experience are less likely to succeed in this position because of a higher degree of orientation to problems of business and industry and lacking experience with educational systems.

The director should have some training in the technical aspects of data processing in addition to his background in education. The technical competence of the director should be sufficient enough to speak the language of data processing and enable him to understand some of the mechanical aspects of equipment installations. Without this knowledge he will be at the mercy of his technical staff and unable to converse intelligently about specific problems. The director must know both systems and people and must be able to work with both.

The director's assignment should be on a twelve-month basis; his hours will not likely be as regular as those of an educational administrator or teacher. There may be requirements that demand he work weekends and holidays to keep the center functioning smoothly. In general, then, the director must plan, direct, organize, supervise, and evaluate the educational prospects in the application of electronic computers to educational problems in schools.

Some specific tasks include the following:

1. Acts as a liaison agent to data processing equipment manufacturer's committees.
2. Supervises collection and processing of data.

3. Analyzes and interprets data to superiors, subordinates and users.

4. Makes progress reports to advisory committees, boards, and supervisors.

5. Prepares reports, research project papers, and methods of evaluating results.

6. Evaluates and analyzes equipment.

7. Develops specifications for equipment.

8. Conducts and supports simulation studies.

9. Applies new technology to educational problems.

10. Assists in the selection of staff members.

11. Assists in the planning, organizing, and supervising the activities of the staff.

12. Provides orientation and necessary on-the-job training for new and tenure staff members.

13. Assists in the establishment and maintenance of an educational data processing library.

14. Provides consultation to local school systems on educational applications of electronic data processing.

15. Conducts and establishes communication channels with public school personnel through in-service training and other feasible programs.

16. Establishes and maintains vocational programs to train students in the operation and use of data processing equipment.

17. Prepares and establishes a center's budget proposal on the basis of need and operational considerations.

In terms of experience, it would be desirable for the director to have at least three to five years of experience as an administrator, supervisor, or education research worker with a broad background knowledge of public schools and data processing equipment.

Manager of Data Processing

Often the manager of a data processing system and the director of information services are one and the same person, especially if the system is small. As data processing services expand in an organization, it becomes necessary to employ a person directly responsible for the day-to-day management of personnel and equipment in the center. The occupant of this position would report directly to the director of information services and is directly responsible to him.

The manager should be a person trained and experienced in business applications. Knowledge of educational functions can be provided by the director during initial stages of installation and development. The manager will be a technical expert who will be called on to answer specific questions on how an operation is to be handled by specific machine application. This position also requires some experience and training in systems analysis. The manager will actually take data and relate it to information through input-output stages that will provide for the needs of the users through a logical sequence of machine operations. The manager must also be able to evaluate the qualifications of center personnel. Along with the director he will be responsible for hiring, training, and directing the technical personnel in the center.

A data processing manager should have one year of experience as a supervisor of electronic data processing, accounting-tabulating machine supervision, or systems analyst. An alternative to the above would be two years of experience of planning, direction, and supervising the work of a staff performing varied accounting and statistical functions employing a variety of data processing equipment. This person should possess post high school education in the areas of data processing method and equipment and business management.

Some of the more specific tasks a manager undertakes are as follows:

1. Responsible in absence of director for planning, organizing, directing, evaluating, and coordinating the activities of the data processing center.
2. Develops and maintains the data processing system, programs, and related machine procedures for maximum utilization of data processing equipment.
3. Directs all machine, control and file operations.
4. Evaluates data processing equipment and technology.
5. Reviews operations and analyses equipment performance and deficiencies.
6. Assists in selecting technical employees.
7. Maintains appropriate staff training programs.
8. Evaluates the performance of personnel and recommends action to be taken.

9. Justifies equipment and personnel needs in the center to appropriate supervision and budget control groups.

10. Develops and maintains effective communications and working relationships with other governmental jurisdictions.

Data Processing Systems Analyst

In smaller system installations the job of the systems analyst is often handled by a combination director-manager-analyst, all the same person. Again, as the system grows, the systems analyst is normally added after the director and/or manager. If the system is not large enough for a systems analyst, then this position and its incumbent duties are handled jointly by the director and/or manager. The point at which the systems analyst should be a permanent member of the data processing team is difficult to ascertain. Perhaps this becomes the qualified judgment of the director and other administrative bodies who make policy decisions concerning the center.

The best qualified estimate of this point would have to be when the director and/or manager feel they are overburdened with some of the tasks that are normally in the domain of the systems analyst.

The tasks of the systems analyst are typically some of the following:

1. Makes major studies of other accounting and office systems.

2. Formulates new or revised electronic data processing or punch card machine systems to meet accounting, statistical and reporting needs.

3. Analyzes the feasibility of the application of data processing equipment to specific operations.

4. Prepares time and cost data and determines unit cost data.

5. Prepares reports with recommendations based on studies and surveys.

6. Prepares work flow charts and designs card forms and report forms.

7. Develops detailed machine procedure and wiring diagram (sometimes with assistance of the programmer.)

8. Prepares manuals of operation and guides or assists in the installation of procedures and systems and the training of personnel.

9. Analyzes budget requests for data processing equipment and makes recommendations on their feasibility and necessity.

10. Interviews and consults with departmental officials and officers of state agencies.

11. Directs the operations of the computer programmers.

The qualifications of the systems analyst could be broad and varied. This individual should have three years of supervisor or procedures experience in electronic data processing or punch card machine work. More weight should be given to the candidate's demonstrated ability to devise and install a variety of data processing systems using different makes of equipment. It is desirable for this person to have a college degree. Minimum qualifications include post-high school training, particularly in equipment analysis and data processing procedures. In addition, he should have considerable programming experience and training, since his association with the center's programmers will be extensive.

Programmer I

The programmer is another key person in the operation of a data processing center. Generally the chief programmer participates in the initial planning and writes difficult and complex programs for major projects to be processed by an electronic data processing machine and related equipment. One of the difficulties facing officials of major data processing installations is the inability to find qualified programmers. One reason for this is that computer programming requires skill in dealing with mathematical concepts and logic. The programmer I should have at least one year of experience performing the duties listed below. But, if such a person is not available, the candidate should possess two years of responsible programming on machines similar to the ones that will be installed in the center where he will be working. The latter individual should be ready for a promotion and possess the potential for such a move. Many programmers move from programming experiences into jobs as systems analysts or managers. Employers should be looking for programming employees with the potential for upward mobility within the organization.

Some of the tasks of the programmer are as follows:

1. Participates in review and definition of problems with particular emphasis on programs assigned.

2. Prepares outline logic diagrams and block flow diagrams to indicate essential operations to be performed from mutual stages to completion of job.

3. Allocates work area in computer by reserving memory positions for input and output temporary storage, processing and controls.

4. Develops detached flow charts for logical machine operation.

5. Translates flow chart steps into coded instructions for movement of data in the computer.

6. Prepares test data for testing programs on the center's equipment.

7. Prepares machine operating instructions for operators.

8. Develops test programs until a program works with no interference or errors. This process is known as "debugging" the program.

9. Trains control operators and other operators who work with on-line and peripheral equipment.

Programmer II

A programmer II classification is just a step below that of a programmer I. The jobs have many similarities, but a programmer II has less responsibility and is concerned more with the many details of operation assigned him by the manager. The programmer I is normally the head programmer and, if additional programmers are needed, they usually assist and are accountable to the chief programmer. The tasks listed for programmer I will suffice in our study of a programmer II category, but the emphasis is obviously less on each item and final determination of programs, procedures, and operations rests with the head programmer.

The qualifications of a programmer II are necessarily less than those of the head programmer. He should have one or two years experience equivalent to a service tabulating machine operator or higher. His formal training should consist of a minimum of programmer training on the kinds of equipment to be used at the center where he will be working and preferably at least two years of college. Again, this person should have high aptitude in the mathematical sciences and possess a logical mind.

Machine Supervisor

A machine supervisor is only utilized in more advanced data processing installations where the total number of machine operators is over 10 to 15. When this position in the organization is not filled, the responsibilities are normally assumed by a variety of other people, including the manager, programmers, systems analyst, and machine operators. The qualifications of a machine supervisor should include the following:

1. At least one year's experience as a machine supervisor.
2. Two to four years experience as a machine operator.
3. Minimum of high school education with preferable post high school training in machine operation and supervision.

The machine supervisor will typically perform the following tasks:

1. Directs and reviews work, gives instructions, maintains discipline, and generally supervises employees operating various types of data processing machines.
2. Assigns priorities to work orders for maximum utilization of available equipment to meet work schedules.
3. Supervises the preparation of reports and keeps records.

Machine Operator

A machine operator is a necessary member of any data processing center regardless of size. There likely will be more than one person assigned as an operator in large centers and especially where the center operates on more than one shift. The machine operator performs the following tasks:

1. Operates electronic data processing equipment.
2. Makes standard wiring and other adjustments to tabulating and sorting equipment to permit varied kinds of tabulations and sorts.
3. Assists with the filing of cards, tapes, disk packs and related data.
4. Makes reconciliations, reports, and statements.
5. Manually summarizes the tabulated data.
6. May direct the work of other operators or clerks.

The machine operator should have at least six months' experience in the operation of data processing machines. He should have completed high school; additional schooling in machine operation is desirable.

Keypunch Operator

A data processing center will need several keypunch-verifier operators. The keypunch operator performs the following:

1. Provides information on tabulating cards from accounting or statistical documents or from coded work sheets.
2. Verifies punched cards for accuracy.
3. Assists in the coding of documents.
4. Performs simple sorting or tabulating operations.
5. Files and checks tabulated cards.
6. Performs other related clerical tasks as required.

Keypunch operators should possess the following qualifications:

1. Six months experience operating keypunch machines; or
2. Ability to punch at the rate of 7,000 columns an hour from average copy. Punched data should not contain more than 5 per cent errors.
3. Education equivalent to high school diploma with additional training in keypunch operation desirable.

In a large educational data processing center with several keypunch operators a keypunch supervisor would be commonplace.

Clerk-Typist

A clerk-typist is more than just a typist. This person may be responsible for some machine operating tasks in addition to straight copy typing. Because of the similarities of keypunching and typing, the clerk-typist could operate in either situation with little additional training. The clerk-typist classifies, sorts, and files correspondence or other official documents. This person also types data on business documents, forms, or other documents. Typing correspondence is also the responsibility of this person. If the data-processing center is small, the position may require that this person serve as receptionist and telephone operator.

Because of the varied duties performed by the clerk-typist, the person hired for this position must have other characteristics in addition to those of the keypunch operator. The clerk-typist must be a neat and well organized person because of the office filing and correspondence done with outside persons or organizations. In addition, a clerk-typist must be well dressed and have a pleasant personality because the position may require serving as receptionist and telephone operator.

The need for machine operators, programmers, keypunch operators, systems analysts, and clerical help will be dependent on the size of the operation including the amount of equipment and output demand or need of the organization. The general cognitive level of data processing people should be relatively high. Specific aptitudes in certain areas are also necessary. Many equipment manufacturers have aptitude tests which they will be glad to supply on request. Grades received on these tests have proved to be strongly correlated with subsequent success in the data processing field. In addition there are other important qualities which need to be considered. Among these are experience and past performance of individuals being considered, educational background, interest in data processing, and knowledge of those areas for which the person is being considered.

Many persons have entered the data processing field because it is a growing, dynamic and new vocation. Some are competent and remain, others drift to other jobs. In order to obtain and retain competent personnel it is necessary to provide monetary compensation for employees communsurate with their knowledge and attributes and at the same time compete with other organizations who employ the same type of personnel. Generally, educational institutions have been lower in salary schedules of comparable positions in business and industry. Therefore, educational institutions must either increase salaries so that they are competitive, or face the possibility of hiring less than competent personnel or losing competent personnel to business organizations. In the long run it may be less expensive to pay staff members an adequate salary than to train new ones at frequent intervals. Production also suffers if a data processing

center is faced with the prospect of constantly changing and training staff. Continuity of production must be assured and certainly a defensible way of doing this is to hire the best possible people and pay them competitive salaries to assure their retention.

CHAPTER II

A SUMMARY OF FINDINGS

This study was designed around the notion that an educational data processing center should include three basic areas for concern, namely;

1. Liveware, to include personnel for planning, organizing, and developing data processing activities into a fully operational center;
2. Hardware, to include equipment needed for processing data; and
3. Software, to include computer programs, paper forms, data processing cards, etc.

A survey of "what is" generally regarding these three areas of educational data processing was presented in Chapter I as a prelude to assist in determination of "what ought be" for a data processing division of the Wabash Valley Education Center.

Several steps were taken to ascertain information that would be helpful in answering such a question. Among such activities were:

1. A study of some Indiana school corporations which have operational data processing centers.
2. Interviews with representatives of the several vending companies which supply data processing equipment and services for the geographic area of the Wabash Valley Education Center.
3. Lengthy discussions with technical data processing personnel employed by the Computer Sciences Center of Purdue University.
4. A study of the future plans for providing data processing services to public school corporations by the Indiana Department of Public Instructions.
5. A review of data processing operations in an Intermediate School District in the State of Michigan with central operations at Pontiac.
6. A study of evaluations of data processing services by school officials who have purchased such services from banks and other external agencies.

For convenience the study was viewed in six dimensions. The first five dimensions included:

1. Assessment of need and identification of services.
2. Operational considerations.
3. Resource requirements.

4. Fiscal considerations.

5. Time considerations.

The sixth dimension was a pilot study of a computerized payroll problem for the West Lafayette Community School Corporation. The complete process beginning with initiating activities of collecting needed data for school employees and punching data cards to a final process of writing facsimile payroll warrants with the computer was manipulated using data processing facilities at Purdue University.

Findings of the study regarding these six dimensions as they pertain to a regional data processing division for the Wabash Valley Education Center will be presented in the sections that follow.

Assessment of Need and Identification of Services

Perhaps concern for data processing as a type of service that could be provided for member schools by the Wabash Valley Education Center partially stemmed from responses on questionnaires administered to professional personnel of member schools in April and May of 1966.[1] Examples of types of data processing services suggested by those persons responding to the questionnaire were scheduling, grade reporting, financial accounting, preparations of specifications for competitive bidding, scoring and analyzing standardized tests, and providing assistance in research data analysis.

In addition to the high level of interest indicated from the previous study, it was found that several school corporations were either purchasing some data processing services from outside agencies or exploring the possibility of doing so in the future

Discussions with officials from the Indiana Department of Public Instruction revealed that most school data collected at the State level is processed by electronic processing equipment. It appeared highly reasonable that a regional data processing

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[1] Norbert J. Nelson et.al. A Cooperative Study Relative to the Proposed Wabash Valley Education Center, Studies in Education No. 7, Purdue University, 1967. pp. 68-128.

center could collect and analyze the data for the region and output from the regional data processing activities could yield input for State operations in a machine usable form with conceivable savings in processing effort for both the local educational agency and the State Department of Public Instruction. The Wabash Valley Educational Center could act as a pioneer for these activities, hopefully to be followed by other regional data processing establishments. Similar arrangements are well under way in some other states, with California and Michigan cited as leading examples. The regional center performs data processing operations for its member schools, thereby avoiding vast duplication of effort and relieving school personnel of many mundane managerial tasks for a greater amount of professional time to devote to direct instructional processes. In Iowa, the State Department of Public Instruction has initiated a pupil accounting system as a service to all public schools in the state.[2] The Iowa system, known as "CardPac", has been in operation for three years. Although regional processing centers have not been utilized in Iowa, the use of centralized facilities which would not be feasible for each school district to provide has given some insights of how one state has provided school districts with assistance in processing routine data.

Assistance has been provided to local schools by the Indiana Department of Public Instruction for processing staff personnel data, pupil transportation data, as well as others. However, because of the size of such accounting systems for an entire State, the amount and type of data "feedback" that could be helpful in local decision making becomes limited. The potential for developing such data processing services to public schools at a State level in the near future in light of limited resources appears unlikely. However, the notion of a district or regional data processing center appears much more defensible to meet the urgent needs which obviously have not been met for the schools participating in the Wabash Valley Education Center.

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2 Iowa State Department of Public Instruction, CardPack Administration Manual, 1967-68.

From the foregoing discussion, the need for assistance in processing the increasing amounts of data of contemporary school corporations appears evident. With a basic need established, a second consideration seems to be the kinds of data processing services that could be identified as those most appropriate for an area educational data processing division to offer to its member educational institutions. Such listings of services could become quite nebulous and therefore meaningless. To avoid this pitfall, the services perceived as most appropriate for consideration were grouped into broad categories under two separate classifications, (1) services for the internal operation of the Wabash Valley Education Center, and (2) services to be provided to member schools of the Center.

Regarding internal services for the Center, those considered as of primary importance included:

1. Financial accounting for the complete activities of the Center such as payroll, accounts with member schools, accounts with vendors, accounts with Federal and State agencies and in addition perhaps some consideration could be given to cost accounting the many kinds of services offered to member schools for assistance in fiscal decision making.

2. Property accounting to include inventory processing, materials and equipment loan processing, etc.

3. Accounting for employees of the Center with major attention to processing data relevant to the full-time staff and part-time consultant and other staff whose services are used by the Center on a retaining basis.

4. Analysis of data for ongoing research of the Center.

Services which could be offered to member schools included:

1. Assistance in financial accounting including such services as payroll accounting, end of month account balance reports, annual statements of accounts, cost accounting services, inter-corporation cost studies, etc.

2. Accounting for staff, professional and others, with State reports as subsidiary output to the accounting procedures.

3. Pupil accounting to include pupil census data, average daily attendance and/or membership records, grade reporting, personal data, permanent pupil accumulative records, etc.

4. Program accounting including such services as class scheduling, numbers of pupils requesting course offerings with some application for continuing education programs, data regarding course drop-outs plus many other kinds of data analyses associated with the educational program.

5. Accounting for equipment and facilities with such output as numbers, condition, and ages of various types of equipment, replacement schedules for budgetary consistency, records pertaining to buildings and sites, etc.

6. Scoring of standardized tests with analysis of individual and composite data evolving from the tests.

7. Assistance with analysis of data for research.

8. An inventory depot with a stock requisition system where the requisitions are processed electronically with the processed output providing the basis for distribution of stock.

9. A specification file for commonly purchased supplies and/or equipment where a school wishing to let bids for a given item requests the specifications from the data processing division and the computer calls for the set of specifications filed in the computer storage. Output is printed specifications which would avoid lengthy and repetitious writing of standardized specifications.

10. Data processing instruction including training for keypunch operators, machine operators, programmers and other data processing vocational training.

11. Computerized instruction where the computers are used to interact with the student using a remote access terminal, such as a keyboard terminal, for access into the computer memory.

There are many other data processing applications that could become of primary consideration as the processing division gained more sophistication in providing user services. It can readily be seen that the potential of an area center for data processing would be limited only by fiscal resources and the amount of creativity or imagination of the personnel operating the Center.

Operational Considerations

A most important aspect of a newly formed educational data processing center is highly successful results on the first undertakings of the center. To experience failure with many people involved who know little about data processing activities causes an early loss of confidence in the potential services of the center. Perhaps one of the primary considerations for avoiding failure is adequate planning. To plan properly requires highly competent people and a considerable amount of time. Therefore, an educational data processing division would likely meet with greater success if the project

were initiated in phases with the first phase devoted to planning and a second phase for initiating operational activities.

Thus operational considerations would pertain primarily with the second and later phases of the center and deal primarily with such questions as the type of computer configuration that would be most applicable, whether equipment be purchased or rented, amount of memory or storage capacity, access to greater memory for the few jobs which require such, etc.

In the design of a computer configuration, consideration should always be given to the possibility of expansion and growth of the system. As activities of the center increase greater equipment capability is needed. In the early phases of operation a center could not economically justify a system with capabilities and memory needed for more highly developed processing. For these reasons, it usually would be most feasible to consider only a first generation computer, that is, a system that will perform needed data processing activities but on a smaller scale and slower rate. A minimum amount of information storage, perhaps 8,000 characters, would be adequate for the first phase of operation.

Basic in-line equipment would include such equipment as a card read punch, a printer, a few disk storage drives, a console inquiry station and several disk packs.

Peripheral equipment for early operational consideration would include such minimal equipment as keypunch machines, verifiers, card sorters, and a card reproducer with mark sense reading capability.

As processing needs increased, additional storage, in-line and peripheral equipment, would be added. At a later phase of operation, perhaps the center would replace the first generation computer with a second or third generation computer with much greater storage and speed capabilities. If a second generation computer is used, final progression in operational equipment would lead to a third generation computer for additional processing capability or as an alternative, additional first or second generation processing units to supplement the processing load carried by the basic system.

Regarding leasing versus purchasing, several factors should be considered. Most leasing arrangements include maintenance service. Data processing equipment is changing rapidly and obsolescence of equipment is worthy of consideration. As equipment needs increase, rental equipment could be easily exchanged with the vendor for larger equipment at a higher lease price. Disposal or exchange of fully owned processing equipment might not be so convenient. In total, it would appear advantageous for the Wabash Valley Education Center to lease equipment, at least during the early and rapid growth stages of the center.

It was considered doubtful whether all processing could be done at any one time on the equipment leased for every day usage. Moreover, to lease adequate computer capability for an occasional service requiring vast amounts of data storage such as student scheduling would provide inefficient use of the data processing facility. Arrangements to purchase time can usually be made with data processing equipment vendors or other agencies with large computer installations. If frequent enough, such an arrangement could be by a direct line to the larger processor with an automatic timing device. For less frequent needs, transporting technicians, software and input data to the large processor has proven more feasible.

Additional factors that should be considered regarding hardware include:

1. Discounts for rental of equipment to educational institutions.
2. Amount of time between order and delivery of equipment.
3. Availability of compu er programs and other software as a service by the vendor
4. Availability of maintenance service to minimize "down time" in operation of the data processing facility.
5. Availability of testing time on vending company computers during the time between ordering the equipment and delivery date.

Finally, there are several operational considerations that should be noted regardin a facility for housing the data processing center. Environmental conditions must be closely controlled. Data processors produce a considerable amount of heat. The compute

will not operate properly if provisions are not made to expel the heat build-up from the operational center. Further, humidity must be closely controlled for cards and other software to be properly manipulated by the equipment. Therefore, the building facility for housing the operational equipment must have adequate air conditioning.

Three phase, four wire current is necessary for operation of the hardware. The processing unit must be on a clean line. By clean line, reference is made to the necessity of avoiding interference by other electrical equipment. For example, a compressor for the air conditioning system would create interference for the processor and destroy the otherwise high dependability of processing operations.

Equipment, both in-line and peripheral, should be arranged so as to maximize operational efficiency.

Resource Requirements

Probably the primary resource consideration for successful launching of an educational data processing center is a staff of competent, well-qualified liveware. Key among those staff appointees would be a chief administrator or manager of the regional data processing division. Development of software and planning a defensible hardware configuration become subsidiary concerns or "tools" for performing services of the centralized operation.

As the services of the center increase, personnel or liveware needs increase accordingly, but basic to the center at initial stages would be a programmer and adequate clerical staff. Perhaps the first addition to the initial staff would be a second programmer and machine operators, that is, keypunch personnel and a computer operator. As sophistication of the center activities increase, a systems analyst would be needed who would assume responsibility for expediting the operations of data processing services and directing the activities of the programmers. Job descriptions of each type of personnel was presented in Chapter I of this report.

It would appear highly feasible to use some part-time personnel in operating a data processing division with the Wabash Valley Education Center. The proximity of Purdue University and its curricula in computer sciences provides an opportunity for staffing the center that merits consideration.

Other resources would predominantly fall in the software and hardware categories. Possible needs for hardware configuration were discussed briefly in the preceding section. The first phase of the center was perceived as a planning phase and hardware needs would be limited to purchasing time on computer installations for testing programs and processing small amounts of data. In the second phase, the following equipment would be minimal:

1. First generation computer including -

    a. Central processing unit, 8K storage
    b. Card read punch
    c. Printer
    d. Three disk storage drives
    e. Console inquiry station
    f. Nine disk packs

2. Peripheral hardware including -

    a. Printing keypunch
    b. Interpreter keypunch
    c. Verifier
    d. Sorter
    e. Mark sense reproducing punch

Later phases would call for increased hardware according to the speed of increasing services rendered.

Software needs would be primarily of two types (1) stock cards, and (2) continuous stock paper forms. As the center expanded, specially printed cards and forms would become necessary. For example, payroll accounting would demand some specially printed forms for each school district.

Fiscal Considerations

Costs become a major preliminary consideration in completing any feasibility study. In the case of data processing equipment, the total fiscal outlay is sizeable. For this

reason an area or regional approach could spread the cost over a much larger pupil population, therefore providing services at a per pupil cost that may be competitive or more economical than other methods of processing data plus providing the added advantage of capability for performing data processing activities that would be impractical or impossible manually.

Cost considerations are relative and therefore estimates contained in this study are only used as a basis for arriving at very general approximate costs. Estimates were carried only through Phase II for the Center because the many alternatives for expanded service offerings and equipment needs beyond that point of operation would prove estimates meaningless.

Estimates for Phase I and Phase II are presented below. To arrive at estimates for Phase II, two first generation systems were used as sample alternative configurations that might adapt well for the kinds of services anticipated for the center. Both systems are manufactured by International Business Machines. Other vendors have hardware of similar capability that should be considered by officials when ordering decisions are made. The IBM 1620 and 1401 processing systems were chosen for this study for the following reasons:

1. The availability of a local marketing representative for assistance in price estimates;
2. Sizeable discounts on the hardware when used for educational purposes;
3. The availability of many computer programs supplied by the vendor at the users' request. These programs have been established over a period of several years.
4. Both systems have histories of several years of successful performance.

PHASE I

ESTIMATED EXPENDITURES

Liveware	
Manager of Data Processing	$12,000 to $15,000
Programmer	8,000 - 9,000
Clerk-typist	4,800 - 5,000
Total Estimated Liveware	$24,800 - $29,000
Software	
Supplies and Miscellaneous	2,000 - 2,500
*Hardware	
Machine rental for Pilot Programs	800 - 1,000
Other	
Office Rental (500 sq. ft. @ $4.00 per sq. ft. per year)	2,000 - 2,500
Total	$29,000 - $35,000
Cost Per Pupil (77,722 pupils, 1967-68)	$0.38 - $0.45

*It is the policy of some hardware vendors to allow customers who order hardware testing time on similar computer configurations at no additional cost to the customer. It was assumed in this estimate that plans will be completed for needed hardware and the order placed for the hardware prior to the close of the fiscal year 1968.

PHASE II

ESTIMATED EXPENDITURES

Liveware	
Manager	$13,000 - $16,000
Programmer I	9,000 - 10,000
*Programmer II	7,000 - 8,000
Machine Operator	6,000 - 7,000
3-Keypunch Operators (12 mos. @ $40.00 per mo.)	14,400 - 15,000
1-Clerk-Typist	5,000 - 5,200
Total Estimated Liveware	$54,400 - $61,200

*May be occupied by two or more part-time personnel, e.g., Purdue University students.

Software	
Card Stock	$ 5,000 - $ 6,000
Paper forms	18,000 - 20,000
Miscellaneous and Contingency	7,000 - 7,500
Total Estimated Software	$30,000 - $33,500

Hardware - In-Line

	Plan A IBM 1620 System (70% Discount)*	Plan B IBM 1401 System (60% Discount)*
Central Processing Unit	$1685	$1995
Core Storage	750	575
Card Read Punch	765	550
Printer	920	775
Disk Storage Drive	650	885
2-Disk Storage Drives	720	720
Console Inquiry Station	n.a.	165
9-Disc Packs	135	135
Total	$5625	$5800
*Less Educational Allowance	-3023	-2801
Net Price (Per Mo.)	$2602	$2999
Net Price (Per Yr.)	$31,224	$35,988

PHASE II (cont.)

Hardware - Peripheral

1 - 026 Printing Keypunch	$ 60
1 - 029C22 Interpreter Keypunch	104
1 - 056 Verifier	50
1 - 083 Sorter	110
1 - 519 Reproducer - Mark Sense	205
Total Per Month	$ 529
Total Per Year	$6348

Hardware - Supplementary Rental

Additional time with larger processor $5,000

	Plan A	Plan B
Total Estimated Hardware (Annually)	$42,572	$47,336

Other

Space Rental 800 sq. ft. for hardware 700 sq. ft. for offices 1500 sq. ft. @ $4.00 per sq. ft. per year	$ 6,000 - $ 7,000
Contingency	1,500 - 3,000
Total Annual Estimated Expenditures for Phase II	$134,472 - $152,036
Cost Per Pupil (77,722 pupils 1967-68)	$1.73 - $1.96

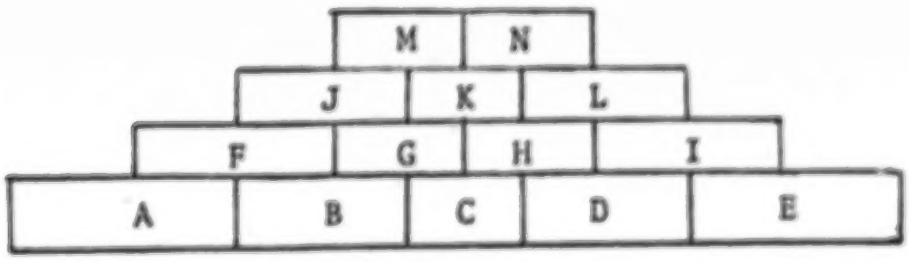
Time Considerations

It became apparent from a study of types of services to be considered that there were no sharp lines of distinction between the many services. One type of service was closely associated with and dependent upon others. Therefore, priorities for offering the services must be established. Changes which occur during the development of the Center may alter the original assignment of priorities and the emphasis to be placed on each service.

Data which are yielded as output from one processing application in the Center may become input for a second or several later applications. For instance, data from a payroll computation gives rise to later development of a staff accounting system, and when combined with other financial data contributes to the development of a total system for financial accounting. In other words, operation of the Center may be viewed as a system of building blocks. Such a concept is illustrated in Figure II. Letters A through E designate the basic data processing operations for the Center and would receive highest priority in regard to time of initiating the activity. Output from operations in A through E would yield output for the more complex and lower priority operations denoted by letters F through I, and so on until the most sophisticated data processing operations with the lowest priority, but demanding the greatest amount of expertise, are undertaken.

FIGURE II

A MODEL FOR ESTABLISHING DATA PROCESSING PRIORITIES



In the first operational phase of the center, activities receiving the highest priority should be those which demand the smallest number of persons from member school

corporations providing the input. The fewer persons providing input data likely will reduce the incidence of error in these data. For example, to initiate a program for pupil grade reporting would involve input data being supplied by every participating teacher. A more defensible first priority activity would by payroll accounting where only one clerk from each cooperating school district could be made responsible for supplying the input data.

Using the foregoing rationale as a basis for establishing priorities, the following list of center operational activities suggests one logical approach to establishing a time schedule for the Center.

1. Payroll check writing pilot project.
2. Payroll check writing services for member schools. (base project number one)
3. Payroll accounting (by-product of item number two above)
4. Staff accounting (by-product of payroll accounting)
5. Analysis of data for state report form TD-1 (by-produce of staff accounting)
6. Test Scoring and Analysis (base project number two)
7. Data analysis for research of member schools and the Wabash Valley Center (base project number three)
8. Pupil accounting (base project number four)
9. Grade reporting (by-product of pupil accounting)
10. Pupil scheduling (by-product of pupil accounting and staff accounting)
11. Personnel contract writing (by-product of staff accounting)
12. And so forth for the several other types of services that may be made available to member schools.

The payroll check writing pilot project was performed as a part of this study and will be discussed in the following section of the report.

It was perceived by the consultant team that the first year, Fiscal Year 1968, shou be devoted to Phase I, the planning phase. During this phase, the basic hardware configuration should be ordered. A minimum allowance of four months should be made for delivery of hardware. Also during Phase I, the Center staff would be developing software for the highest priority data processing activities, i.e., those activities which would be initiated during Phase II, the first operational phase of the Center.

Phase II would be planned for Fiscal Year 1969. Processing activities might inclu payroll checkwriting and test scoring and analysis with progression into lower priority activities as rapidly as time and resources of the Center would justify. The Center could in this manner become completely operational in the listed activities during a

time span of four to five years. Evolving from the expansion process would be a large "data bank" to supply input for future data processing services both for the Center and member school corporations.

Pilot Study of a Computerized Payroll Problem

Every school system should be concerned with the educational innovations that are evolving through the invention of man-made machines of the last ten years. Machine systems are here to stay and will increasingly effect all types of educational agencies in the years to come. These systems have demonstrated their potentialities to do much in providing services and information heretofore only achieved by countless hours of teachers' and administrators' time working on reports and figures essential for the efficient operation of schools.

Machines may be programmed to work in a way that relieves many people of the minuscule details of paper work. Machines may be programmed to write checks, print out ledgers, teach, print class rosters, score tests, print achievement records, print cumulative records, make class schedules, report attendance, and do numerous other operations. The machines are only limited by the managers ingenuity in utilizing the potential of the machines available to him. The question left to answer is one of determining whether specific operations are economically feasible for a particular system.

The purpose of this pilot study was to determine whether payroll check writing is an operation that would be feasible among the operations assigned to a Data Processing Division of the Wabash Valley Education Center. In particular, the problem was one of discovering if payroll operations were economically feasible in such a center in terms of time, machinery, personnel and expenditure required.

Initially, three school corporations were selected for the study. After some involvement with the very time consuming task of gathering the necessary data, the consultants decided that studying only one corporation would be sufficient to either prove or disprove the feasibility of the operation. Further, school payroll systems for the

three school corporations are very similar, as are all Indiana school payroll systems. The payroll system used in the analysis was that of the West Lafayette Community School Corporation.

Data were collected from the West Lafayette Community School Corporation Superintendent's office. The data consisted of the Social Security number of each person paid for the payroll of February 1, 1968. Social Security numbers were used in place of names to keep the data anonymous. In addition, information was collected on account number paid from, appropriation used, regular earnings, miscellaneous adjustments, Federal tax withheld, FICA, Indiana Gross Tax, teacher retirement, insurance, and annuity payment. These data were recorded on punched cards for manipulation and analysis.

Fortran IV computer programs compatible with the Purdue University IBM 7094 were written to accomplish the following tasks:

1. Compute the deductions and net pay and print out a payroll check indicating itemized deductions including gross and net pay for each employee. Both check and itemized stub were written.

2. Prepare a payroll record that lists each name, account, gross pay, deductions, net pay and totals for each employee and all employees combined.

3. Prepare an appropriation, encumbrances, disbursements, and balances ledger which prints out an up-to-date accounting including all encumbrances and resultant unencumbered balances of all account funds.

Writing programs to perform the prescribed tasks took approximately 30 hours for each of the three programs written. Due to the many similarities among school payroll operations, subsequent programs could probably be written in less time. Punching data into card form took considerably less time. For the 306 employees for which data were retrieved and converted to punched cards, it took under six hours (or about one minute per person) to complete this particular task.

Reading, analysis, and printing out the payroll, payroll records, and ledger of appropriations, encumbrances, disbursements and balances on the computer took considerably less time. On the IBM 7094, whose access time to retrieve one word of information is 1.4 microseconds, the total compilation and execution time to print out the

above information was 71 seconds. The printer that was used for this problem operated at a speed of 1200 lines per minute. An equivalent amount of time on a slower computer, such as the IBM 1401 or 1640 series, might be 10 to 15 minutes for the same operations. The variations would be due to a different program, internal access time, and a slower printer.

Maximum total machine time to output printed reports for 300 people in a payroll operation is estimated to be about six hours or a little over one minute per person. After programs have been written and debugged to perform the payroll operation for each school corporation, no further time is necessary for this phase of the operation. Time has not been estimated for preparing source documents for keypunching or for transferring data to and information from the data processing center. This is a rather nebulous quantity to estimate because of varying factors and conditions implied in these tasks.

Personnel time would be around 12 hours a month for a keypuncher if a school corporation pays twice a month. The time required of a machine operator to input data and secure printed information for each run cannot be estimated.

The cost of operating the machinery for performing the payroll operation cannot be specifically determined. This cost is dependent on the configuration of machinery in the computing center, the rental cost of each machine, the speed of the computer and peripheral equipment, and a variety of other factors not considered here. Costs are also dependent on the total operating or core time for the computer. Generally, if more similar operations can be run in succession, the equipment is less expensive to operate. The costs will be lessened if more school corporations would decide to have the Data Processing Center handle their payroll operation, thereby increasing the volume of output.

From all the information gathered relevant to this study, it would appear that the payroll operation is indeed a feasible and workable operation for the Data Processing

Center. Because of the many variables inherent in the operation, many of the specific costs cannot be predicted, but generally it can be reported that payroll operations handled by a computer facility would be more economical and efficient than present mechanical methods utilized in some school systems. The fact that the payroll operation lends itself to data processing facilities can be recognized by observing the number of businesses and industries who have converted their payroll operation from mechanically oriented processing to electronic data processing. Evidence from this pilot study suggests that the payroll operation should be one of the first processes incorporated into a Data Processing Division for the Wabash Valley Education Center.

Conclusions

A central data processing service by the Wabash Valley Education Center offers a defensible approach to processing educational data for member schools. Sizeable capital outlays will be required to provide a functional data processing center which is staffed with highly specialized personnel. The large costs involved place limitations on the feasibility of an individual school district undertaking such activities. For school systems to singularly provide a data processing service might be considered a misallocation of resources because of inefficient utilization of personnel and equipment.

A data processing division of the Wabash Valley Educational Center was perceived as potentially becoming a service agency that operates between the member local school corporations and the State Department of Public Instruction. Such an arrangement would help eliminate many of the present manual data processing activities carried out by local schools in reporting educational data. In addition, many data processing services not now available could be provided to local schools, both public and private, in the geographic area served by the Center.

Several key considerations predominate in the establishment of a system for providing central data processing services for member schools. Foremost among these would

be the development of a highly competent and capable staff for the data processing division. The future acceptance of the Center by member schools is highly dependent upon carefully planning and carrying out initial operations of the Center.

Secondly, a hardware configuration should be based upon the types of services to be provided. Provisions for expansion should be "built in" to the system as development of the Center takes shape.

Thirdly, operations should be planned on a priority basis, with highest priority going to the least complex services. As sophistication of the Center increases, complex activities can be initiated. At this point lower priority operations can be successfully undertaken. Consideration in planning should be given to the development of a "data bank" of accumulated output as input for later, lower priority operations.

Finally, primary attention must be focused on completeness and accuracy of output before it is disseminated. Demands upon the Center for rapid feedback will be great in the early operational phases. Accuracy and completeness may tend to interfere with expediency. However, confidence of users in the reliability of output disseminated by the Center is a requirement for long-range, successful operation of an educational data processing center.

The annual cost per pupil was estimated to be less than fifty cents during the organizational or planning phase and approximately $1.75 to $2.00 per pupil for the first phase of operation (Phase II of the project), if all schools participated in the services. One Indiana public school corporation reported a cost of about $ .30 per pupil per year for a data processing payroll service for 173 professional employees. The service included:

1. Earnings and deductions register
2. Cashiers checks and earnings statements
3. Management reports
4. Federal 941a and Indiana unemployment tax report quarterly
5. W-2 forms for Federal income tax deductions

Compared to these charges, an investment of $2.00 per pupil in a Center that would provide multiple data processing services including payroll would appear attractive.

As more liveware, hardware and software are utilized cost per pupil would be expected to increase accordingly. The public school district in Palo Alto, California, reported a per pupil cost of $9.00 for a completely operational data processing center. Approximately 15,000 pupils were being accommodated. The $9.00 figure represented about 2 per cent of the annual operating budget. In Montgomery County, Virginia, 115,000 students were served by a data processing center at an annual per pupil cost of about $8.00 per pupil.